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PRELIMINARY RESULTS OF DETERMINATION OF CHEMICAL ELEMENT CONCENTRATIONS IN THE AEROSOL OF VENUS CLOUDS

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16. Abstract

An x-ray radiometric experiment is described along with the results of measurements of the elemental composition of aerosol in Venusian clouds. A preliminary analysis of the data showed that sulfur is present in the range of heights 63-47 km with mean content of 5.8 mg/m^3 and that chlorine is present in the height range 61-52 km with a mean content of 4.1 mg/m^3. The results of measurements in the range 52-47 km may come to an agreement if phosphorus is present in the aerosol with a mean concentration of 7.7 mg/m^3.

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In order to determine the concentrations of chemical elements in the aerosol of Venusian clouds on the "Vega-1" and "Vega-2" AMS landing vehicles, x-ray radiometric instruments were installed. /120*

The x-ray radiometric method of analysis makes it possible to investigate a sample without destroying it and without changing the conditions of its existence; this is especially important in analyzing a material of unknown composition. The essence of the method may be reduced to the following: during the interaction of electromagnetic or corpuscular radiation with the electron shells of atomic nuclei, electrons escape from one of the shells closest to the nucleus. An electron from a shell farther from the nucleus goes to the empty site and this is accompanied by the emergence of an x-ray photon with a frequency equal to the ratio of the difference in the energies of these shells to Planck's constant (characteristic x-ray radiation).

The characteristic x-ray radiation is transformed in a detector /121
into a current impulse and then with the help of an electronic circuit into a voltage impulse which is proportional to the energy of the x-ray photon. The number of impulses of a given amplitude

* Numbers in the margin indicate pagination in the foreign text.

characterizes the concentration of the corresponding chemical element. In order to obtain a compact geometry of measurements, low energy capacity, mass and dimensions of the apparatus in the experiment being described, ionization of the atoms is done by isotope x-ray sources. The measurement was done continuously during the landing of the landing vehicle in a parachute in the Venusian cloud layer at altitudes ranging from 63-47 km. The aerosol was deposited on an ashless acidproof Petryanov filter which was specially created for the experiment and simultaneously analyzed. In order to ensure the maximum sensitivity of the measurements (maximum mass of the deposited aerosol), the filter had low (~0.1 mm water) standard resistance; this made it possible during the parachute landing of the vehicle in the Venusian clouds to pass ~2 m^3 atmospheric gas through it. The filter's effectiveness in retaining particles more than 1 μm in diameter was 100%.

The device combined four spectrometric channels which continuously analyzed the material being deposited on the filter. The intensity of the characteristic radiation in various sections of the spectral distribution was recorded. As the detectors we used sealed off proportional counters. With the help of two of them, measurements were done in the spectral region corresponding to the characteristic radiation of chlorine, sulfur and phosphorus. In order to separate the radiation of these elements in the aperture of one of the counters, a selective sulfur filter was used. The third counter measured the intensity of radiation in the region of the characteristic energy of iron, and the fourth, the intensity of primary radiation passing through the filter with the aerosol deposited on it. In order to excite characteristic radiation in the region of chlorine, sulfur and phosphorus, radio isotope sources based on radioactive nuclide ^{55}Fe were used, in the region of iron, ^{109}Cd, and for radioscopy of the filter, $^{3}H/Zr$. The construction of the device made it possible to reduce the hum caused by sources extraneous to the given experiment to the minimum (for example, a ^{109}Cd and $^{3}H/Zr$ hum for determining the characteristic radiation of the element group Cl,P,S).

The device operated in the following way. After it was switched on on the command of the landing vehicle, the program timer of the device gave the command to depressurize the analytical cell in which the filter, sources and detectors of ionizing radiation were placed. The input and output valves of the analytical cell were discharged and under the effect of a high-speed thrust, the atmospheric gas began to pass through a filter of area 10 cm^2. During landing the presence and variations in x-ray radiation in the region of the characteristic energies of Cl,S,P were recorded along with variations in intensity in the region of characteristic radiation L - the zirconium series (a channel with a $^3H/Zr$ source). Variations in intensity in the channel which measured the characteristic radiation of /122
iron were above the statistical error of the measurements at altitudes of 54-47 km.

A preliminary analysis of the concentration of chemical elements in the aerosol in Venusian clouds showed that sulfur is present in the range of altitudes from 63-47 km and that its average concentration is 5.8 mg/m^3 and that chlorine is present in the range of altitudes from 61-52 km in the amount 4.1 mg/m^3. Chlorine and sulfur were previously recorded in the cloud aerosol of Venus with the help of x-ray radiometric spectrometers (Surkov et al., 1982).

The results of measurements in the range of altitudes from 52-47 km may correspond if phosphorus is present in the aerosol in average concentration 7.7 mg/m^3.

Significant variations were observed in the concentrations of sulfur, chlorine and phosphorus in the aerosol with altitude; some of these may be related to phase transitions and (or) differentiations of these chemical elements in the cloud aerosol by altitude.

The preliminary data presented here will be refined and supplemented.

In conclusion, the authors would like to express their thanks to V.G. Shumkov, V.G. Rogozovets, V.F. Fateyev, B.V. Zatolokin, and B.K. Morozov for their help in the preparation of individual elements of the x-ray radiometric meter, to G.N. Krasovskiy for his constant support for and attention to this work and to A.V. D'yachkov for his help with information processing.

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